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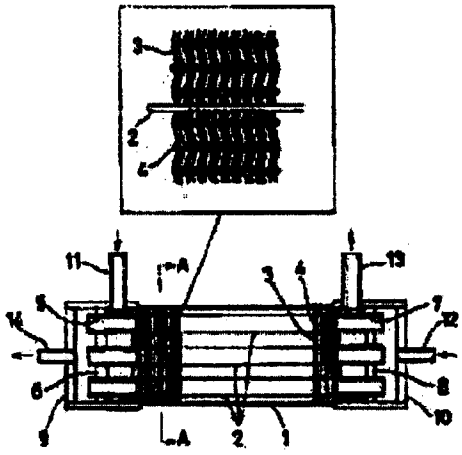
(71)Applicant : AISIN SEIKI CO LTD

(72)Inventor : HIRANO AKIRA

(54) HEAT EXCHANGER



(57)Abstract:

PROBLEM TO BE SOLVED: To reduce intrusion of heat from a high temperature side to a low temperature side in an axial direction, decrease thermal resistance of a joint part of a thin-walled pipe and a wire netting and enhance temperature efficiency by using as a material for the thin-walled pipe a copper alloy of a specified wt.% of Ni made by alloying copper or a copper alloy with Ni.

SOLUTION: Five thin-walled pipes (a copper alloy containing 5-40 wt.% of Ni) 2 disposed in a tubular member 1 parallelly with the tubular member, wire nettings 3 closely stacked in a space formed between the tubular member 1 and the thin-walled pipes 2 and wire nettings 4 closely stacked in interiors of the thin-walled pipes are provided. The stacked nettings 4 are held by stoppers 5, 7 and the thin-walled pipes 2 and the stacked nettings 3 are held by partition plates 6, 8. Lids 9, 10 for the tubular member 1, an inlet 12 for inside passages of the thin-walled pipes 2, an outlet 14 for inside passages of the thin-walled pipes 2, an inlet 11 for an outside passage of the thin-walled pipes and an outlet 13 for the outside passage of the thin-walled pipes 2 are provided

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CLAIMS

[Claim(s)]

[Claim 1]In a heat exchanger which carries out heat exchange, between laminated metal wire gauzes, via a wall A cylindrical member, 1 or two or more light-gage small tubes which are in this cylindrical member and are allocated in said cylindrical member and parallel, This light-gage small tube, outer passages formed between said cylindrical members, and at least one or more inside channels formed inside said light-gage small tube, A wire gauze which is densely laminated by said outer passages, carries out heat contact and forms a heat transfer fin in said light-gage small tube, said inside channel laminating densely and comprising a wire gauze which carries out heat contact and forms a heat transfer fin in said light-gage small tube -- construction material of said light-gage small tube -- copper or a copper alloy -- nickel -- 5 - 40wt% -- a heat exchanger considering it as a copper alloy to contain.

[Claim 2]The heat exchanger according to claim 1 having coated or plated metal of said wire gauze and same material or copper, chromium, nickel, silver, or those alloys on an inner surface of said light-gage small tube, an outside surface, or one of its surfaces, and carrying out diffused junction of said light-gage small tube and said wire gauze.

[Claim 3]The heat exchanger according to claim 1 having coated or plated wax material or adhesives on an inner surface of said light-gage small tube, an outside surface, or one of its surfaces, and strengthening heat contact with said light-gage small tube and said wire gauze.

[Claim 4]Claims 1 and 2, wherein metal coated or plated at said wire gauze is chromium or nickel, a heat exchanger of three statements.

[Claim 5]The heat exchanger according to claim 4, wherein said wire gauze coated or plated laminates in a pitch of at least one or more sheets in a wire gauze which has not been coated or plated.

[Claim 6]In a heat exchanger which carries out heat exchange, between laminated metal wire gauzes, via a wall A cylindrical member, A light-gage small tube which comprises 1, two or more copper, or Lynn deoxidized copper which is in this cylindrical member and is allocated in said cylindrical member and parallel, This light-gage small tube, outer passages formed between said cylindrical members, and at least one or more inside channels formed inside said light-gage small tube, A wire

gauze which is densely laminated by said outer passages, carries out heat contact and forms a heat transfer fin in said light-gage small tube, A heat exchanger, wherein metal which is densely laminated by said inside channel, comprises a wire gauze which carries out heat contact and forms a heat transfer fin in said light-gage small tube, and is coated or plated at said wire gauze is chromium or nickel.
[Claim 7]The heat exchanger according to claim 6, wherein said wire gauze coated or plated laminates in a pitch of at least one or more sheets in a wire gauze which has not been coated or plated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to improvement of a counterflow heat exchanger.
[0002]
[Description of the Prior Art]What is conventionally indicated by JP,60-243484,A as this kind of a device, And Los Alamos Scientific. There are "Low Flow Velocity, Fine-Screen Heat Exchengers and Vapor-CooledCryogenic Current Leads" of Laboratory.
[0003]Being shown in drawing 16 and 17 is indicated by JP,60-243484,A, and it is the conventional heat exchanger. Drawing 16, seven light-gage small tubes with which 101 is parallel to a cylindrical member and 102 is parallel to this in this cylindrical member 101 in 17, the wire gauze densely laminated in the space where 103 is formed between this cylindrical member 101 and the light-gage small tube 102, and 104 are the wire gauzes densely laminated inside light-gage piping. The portion in contact with the wall surface of the light-gage small tube 102 of each wire gauze 103 and 104 is carrying out diffused junction to light-gage piping. The stopper holding the wire gauze 104 at which 105 and 107 were laminated, the diaphragm with which 106 and 108 hold the light-gage small tube 102 and the laminated wire gauze 103, As for the entrance of the inside channel 102a of the light-gage small tube 102, and 112, 109 and 110 are [the entrance of the outer passages 101a of the light-gage small tube 102 and 114] the exits of these outer passages 111a the lid of the cylindrical member 101, and 111 the exit of the inside channel 102a of the light-gage small tube 102, and 113. Thus, increase of thermal conductivity and a substantial heat transfer area are increased by laminating the fine wire gauzes 103 and 104 densely.
[0004]The high-pressure gas which entered from 111 is left from 112, lowering temperature gradually in a heat exchanger with low-pressure return gas. The low-pressure return gas which entered from 113 gets heat from high-pressure gas, raises temperature gradually, and leaves it from 114. At this time, high-pressure gas

and low-pressure gas perform heat exchange.

[0005]When the specific heat at constant pressure of high-pressure gas and low-pressure gas is equal, if heat exchanging efficiency becomes 100%, the gas temperature of the high voltage exit of 112 will become equal at the gas temperature of the low-pressure entrance of 113. The temperature of the low-pressure exit of 114 becomes equal at the temperature of the high voltage entrance of 111.

[0006]However, for a certain reason, not 100% but an inefficient part certainly leaves the efficiency of a heat exchanger at the temperature whose high pressure gas outlet temperature of a heat exchanger is higher than low-pressure inlet gas temperature. Low-pressure outlet temperature is left at a temperature lower than high voltage inlet temperature.

[0007]What is shown in drawing 18, LosAlamos Scientific. It is the heat exchanger shown in "Low Flow Velocity, Fine-Screen Heat Exchengers and Vapor-CooledCryogenic Current Leads" of Laboratory.

[0008]One light-gage small tube in which 201 is located in tubed piping and 202 is located in this and parallel in this cylindrical member 201 in drawing 18 (construction material is copper), The wire gauze (construction material is copper or a copper alloy) densely laminated in the space where 203 is formed between this cylindrical member 201 and the light-gage small tube 202, and 204 are the wire gauzes (construction material is copper or a copper alloy) densely laminated inside the light-gage small tube. The portion in contact with the wall surface of the light-gage small tube 202 of each wire gauze 203 and 204 is carrying out diffused junction to the light-gage small tube. As for the entrance of the inside channel of the light-gage small tube 202, and 208, 205 and 206 are [the entrance of the outer passages of the light-gage small tube 202 and 210] the exits of these outer passages the exit of the inside channel of the light-gage small tube 202, and 209 the lid of the cylindrical member 201, and 207. Thus, increase of thermal conductivity and a substantial heat transfer area are increased by laminating the fine wire gauzes 203 and 204 densely. This heat exchanger can be used as a temperature level in the low temperature region to abbreviation about 4.5K-300K.

[0009]

[Problem(s) to be Solved by the Invention]However, by the following factor, the conventional heat exchanger has the problem that heat exchanging efficiency falls, and mainly the following two are raised.

[0010]Heat exchanging quantity decreases by the heat intruding of the shaft orientations from the elevated-temperature side of factor 1 heat exchanger to the low temperature side, and the efficiency of a heat exchanger falls.

[0011]As a course of the heat intruding of the shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side, the light-gage small tube 102 and the wire gauzes 103 and 104 are mentioned. Copper or Lynn deoxidized copper is being used for the conventional heat exchanger as

construction material of the light-gage small tube 102. If the thermal conductivity of Lynn deoxidized copper at the time of low temperature is 3.0 W/cm-K, for example in 200K, and 0.47 cm2 and length shall be 20 cm and it sets a temperature gradient to 200K for the cross-section area of the light-gage small tube 102, the amount of heat intruding will be set to 14.1W. For this reason, the heat of 14.1W trespasses upon the shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side, and the efficiency of that part heat exchanger falls.

[0012]The up-and-down wire gauze 103 and no less than 104 comrades are joined to the wire gauzes 103 and 104 at the time of heat treatment of the diffused junction of the light-gage small tube 102, since thermal junction also becomes high, heat invades into the low temperature side from the elevated-temperature side through a wire gauze, and the efficiency of a heat exchanger falls.

[0013]Conduction of the heat of an axial right angle direction or the direction of radiation is checked by that the thermal contact resistance of the diffused junction part of the wire gauze 103 of factor 2 outer passages, the light-gage small tube 102, and the wire gauze 104 of an inside channel and a light-gage small tube is large, heat exchanging quantity falls, and the efficiency of a heat exchanger falls.

[0014]In the conventional heat exchanger, diffused junction of the light-gage small tube 102 is carried out to the wire gauzes 103 and 104. However, diffused junction has the fault that only the portion which the light-gage small tube 102 and the wire gauzes 103 and 104 touch at the time of heat treatment is joined. Therefore, the touch area of the light-gage small tube 102 and the contacting parts of the wire gauzes 103 and 104 is small, thermal resistance will be produced into this portion, heat exchanging quantity decreases, and the efficiency of a heat exchanger falls.

[0015]

[Means for Solving the Problem]In a heat exchanger which carries out heat exchange, an invention of claim 1 via a wall between laminated metal wire gauzes A cylindrical member, 1 or two or more light-gage small tubes which are in this cylindrical member and are allocated in said cylindrical member and parallel, This light-gage small tube, outer passages formed between said cylindrical members, and at least one or more inside channels formed inside said light-gage small tube, A wire gauze which is densely laminated by said outer passages, carries out heat contact and forms a heat transfer fin in said light-gage small tube, said inside channel laminating densely and comprising a wire gauze which carries out heat contact and forms a heat transfer fin in said light-gage small tube -- construction material of said light-gage small tube -- copper or a copper alloy -- nickel -- 5 - 40wt% -- it was considered as a copper alloy to contain

[0016]an invention of claim 1 -- construction material of a light-gage small tube -- copper from conventional copper or Lynn deoxidized copper -- nickel -- 5 - 40wt% -- by changing into a copper alloy to contain, heat intruding of shaft orientations from the

elevated-temperature side of a heat exchanger to the low temperature side decreases to or less about 1 / 6, and efficiency of a heat exchanger improves.

[0017]In content of nickel, less than [5wt%], thermal conductivity of a light-gage small tube will become large, and heat intruding of shaft orientations by the side of low temperature will increase from the elevated-temperature side. When content of nickel is larger than 40wt%, an increase in cost of material will be caused.

[0018]An invention of claim 2 coated or plated metal of said wire gauze and same material or copper, chromium, nickel, silver, or those alloys on an inner surface of said light-gage small tube, an outside surface, or one of its surfaces, and carried out diffused junction of said light-gage small tube and said wire gauze.

[0019]By coating or plating metal of a wire gauze and same material or copper and a copper alloy, chromium, nickel, and silver with an invention of claim 2, Diffused junction is strengthened, thermal resistance of a joining section can be reduced, thermal conductivity of an axial right angle direction of a heat exchanger or the direction of radiation can be raised, and a heat exchanger with sufficient heat exchanging efficiency can be provided.

[0020]An invention of claim 3 coated or plated wax material or adhesives on an inner surface of said light-gage small tube, an outside surface, or one of its surfaces, and strengthened heat contact with said light-gage small tube and said wire gauze.

[0021]In an invention of claim 3, since wax material or a binder enters as inclusion between a light-gage small tube and a wire gauze by performing heat treatment after coating or plating wax material or adhesives on an inner surface of a light-gage small tube, an outside surface, or one of its surfaces, a touch area of a light-gage small tube and a wire gauze increases.

[0022]An invention of claim 4 is characterized by metal coated or plated at said wire gauze being chromium or nickel.

[0023]In an invention of claim 4, by coating or plating chromium or nickel on the surface of a wire gauze, when a heat exchanger is heat-treated, it becomes difficult to carry out diffused junction of the up-and-down wire gauze, and heat intruding of shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side decreases, and efficiency of a heat exchanger improves.

[0024]Said wire gauze coated or plated laminated an invention of claim 5 in a pitch of at least one or more sheets in a wire gauze which has not been coated or plated.

[0025]By laminating in one sheet or several sheet pitch in a wire gauze which has not coated or plated with an invention of claim 5 a wire gauze which has coated or plated chromium or nickel on the surface of a wire gauze, When a heat exchanger is heat-treated, it becomes difficult to carry out diffused junction of the up-and-down wire gauze, and heat intruding of shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side decreases, and efficiency of a heat exchanger improves.

[0026]In a heat exchanger which carries out heat exchange, an invention of claim 6 via a wall between laminated metal wire gauzes A cylindrical member, A light-gage small tube which comprises 1, two or more copper, or Lynn deoxidized copper which is in this cylindrical member and is allocated in said cylindrical member and parallel, This light-gage small tube, outer passages formed between said cylindrical members, and at least one or more inside channels formed inside said light-gage small tube, A wire gauze which is densely laminated by said outer passages, carries out heat contact and forms a heat transfer fin in said light-gage small tube, Said inside channel laminates densely, a wire gauze which carries out heat contact and forms a heat transfer fin in said light-gage small tube is comprised, and metal coated or plated at said wire gauze is characterized by being chromium or nickel.

[0027]In an invention of claim 6, by coating or plating chromium or nickel on the surface of said wire gauze, when a heat exchanger is heat-treated, it becomes difficult to carry out diffused junction of the up-and-down wire gauze, and heat intruding of shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side decreases, and efficiency of a heat exchanger improves.

[0028]Said wire gauze coated or plated laminated an invention of claim 7 in a pitch of at least one or more sheets in a wire gauze which has not been coated or plated.

[0029]By laminating in one sheet or several sheet pitch in a wire gauze which has not coated or plated with an invention of claim 7 a wire gauze which has coated or plated chromium or nickel on the surface of a wire gauze, When a heat exchanger is heat-treated, it becomes difficult to carry out diffused junction of the up-and-down wire gauze, and heat intruding of shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side decreases, and efficiency of a heat exchanger improves.

[0030]

[Embodiment of the Invention]The sectional view of the heat exchanger which is the 1st example of 1st example this invention is shown in drawing 1 and drawing 2. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 1 and drawing 2 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3 form between this cylindrical member 1 and the light-gage small tube 2, and 4 are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0031]this example -- the light-gage small tube 2 -- Lynn deoxidized copper to nickel --

5 - 40wt% -- it changes into the copper alloy to contain, for example, cupro nickel. drawing 15 -- Lynn deoxidized copper and a copper alloy -- nickel -- about 10 wt(s)% -- the thermal conductivity of the contained cupro nickel is shown. According to this, for example in 100K, about 1/of cupro nickel serves as 0.4 W/cm·K to 6 to thermal conductivity 2.5 W/cm·K of Lynn deoxidized copper. For this reason, the efficiency of a heat exchanger improves.

[0032]The sectional view of the heat exchanger which is the 2nd example of 2nd example this invention is shown in drawing 3 and drawing 4. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 3 and drawing 4 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3 form between this cylindrical member 1 and the light-gage small tube 2, and 4 are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0033]the metal 19 (for example, copper.) of the construction material same on the outside of ****** and the inside, or one of its surfaces as a wire gauze Since the diffused junction of the portion which contacts a wire gauze light-gage small tube 2 is strengthened when chromium, nickel, silver, or those alloys are coated or plated, thermal resistance can be reduced.

[0034]Although the heat intruding of the shaft orientations of a heat exchanger increases at this time, when copper thickness sets to 2 micrometers, for example, the length of a light-gage small tube shall be 20 cm and a temperature gradient is set to 200K with the mean temperature 200K, the amount of heat intruding is set to about 0.04 W, and it is so small [the increase in the amount of heat intruding] that it can be disregarded.

[0035]The sectional view of the heat exchanger which is the 3rd example of 3rd example this invention is shown in drawing 5 and drawing 6. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 5 and drawing 6 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3 form between this cylindrical member 1 and the light-gage small tube 2, and 4 are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the

outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0036]The copper wax which 15 coated or plated on the light-gage small tube outside, silver solder, nickel wax material or solder, and 16 are the copper waxes, the silver solder, nickel wax material, or solder which were coated or plated to the light-gage small tube inside.

[0037]The thermal resistance of the light-gage small tube 2 and the joining section of the wire gauzes 3 and 4 can be reduced by this, the thermal conductivity of the axial right angle direction of a heat exchanger or the direction of radiation can be raised, and a heat exchanger with sufficient heat exchanging efficiency can be provided. By using the copper wax material whose melting point is still lower, the temperature of heat treatment can be lowered and, as a result, diffused junction intensity of the wire gauze 3 and four comrades can be weakened. The effect that this reduces the heat intruding of the shaft orientations of a heat exchanger is also expectable.

[0038]The sectional view of the heat exchanger which is the 4th example of 4th example this invention is shown in drawing 7 and drawing 8. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 7 and drawing 8 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3 form between this cylindrical member 1 and the light-gage small tube 2, and 4 are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0039]The 4th example is the copper wax, the silver solder, nickel wax material, or solder which 15 coated or plated on the light-gage small tube outside.

[0040]The thermal resistance of the light-gage small tube 2 and the joining section of the wire gauze 3 can be reduced by this, the thermal conductivity of the axial right angle direction of a heat exchanger or the direction of radiation can be raised, and a heat exchanger with sufficient heat exchanging efficiency can be provided. By using the copper wax material whose melting point is still lower, the temperature of heat treatment can be lowered and, as a result, diffused junction intensity of the wire gauze 3 and four comrades can be weakened. The effect that this reduces the heat intruding of the shaft orientations of a heat exchanger is also expectable.

[0041]The sectional view of the heat exchanger which is the 5th example of 5th example this invention is shown in drawing 9 and drawing 10. Five light-gage small

tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 9 and drawing 10 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3 form between this cylindrical member 1 and the light-gage small tube 2, and 4 are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0042]The 5th example is the copper wax, the silver solder, nickel wax material, or solder which 16 coated or plated to the light-gage small tube inside.

[0043]The thermal resistance of the light-gage small tube 2 and the joining section of the wire gauze 4 can be reduced by this, the thermal conductivity of the axial right angle direction of a heat exchanger or the direction of radiation can be raised, and a heat exchanger with sufficient heat exchanging efficiency can be provided. By using the copper wax material whose melting point is still lower, the temperature of heat treatment can be lowered and, as a result, diffused junction intensity of wire gauzes can be weakened. The effect that this reduces the heat intruding of the shaft orientations of a heat exchanger is also expectable.

[0044]The sectional view of the heat exchanger which is the 6th example of 6th example this invention is shown in drawing 11 and drawing 12. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 11 and drawing 12 (nickel. 5 - 40wt% copper alloy to contain), The wire gauze densely laminated in the space which makes 3a form between this cylindrical member 1 and the light-gage small tube 2, and 4a are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0045]In drawing 11 and drawing 12, 17 is chromium or nickel with which the wire gauze 3a of the outer passages of a light-gage small tube was plated or coated. 18 is chromium or nickel with which the wire gauze 4a of the inside channel of a light-gage small tube was plated or coated.

[0046]When the diffused junction of the up-and-down wire gauze 3a and the 4a becomes is hard to be carried out as for this and a thermal combination of the wire

gauze 3a and 4a becomes weak, the heat intruding of the shaft orientations from the wire gauzes 3a and 4a decreases. Therefore, heat exchanging quantity increases that much and a heat exchanger with sufficient heat exchanging efficiency can be provided.

[0047]The sectional view of the heat exchanger which is the 7th example of 7th example this invention is shown in drawing 13 and drawing 14. Five light-gage small tubes in which 1 is located in a cylindrical member and 2 is located in this and parallel in this cylindrical member 1 in drawing 13 and drawing 14 (nickel. 5 - 40wt% copper alloy to contain), 3, the wire gauze densely laminated in the space which makes 3a form between this cylindrical member 1 and the light-gage small tube 2, and 4 and 4a are the wire gauzes densely laminated inside the light-gage small tube. The stopper holding the wire gauze 4 at which 5 and 7 were laminated, the diaphragm with which 6 and 8 hold the light-gage small tube 2 and the laminated wire gauze 3, As for the entrance of the inside channel of the light-gage small tube 2, and 14, 9 and 10 are [the entrance of the outer passages of the light-gage small tube 2 and 13] the exits of these outer passages the exit of the inside channel of the light-gage small tube 2, and 11 the lid of the cylindrical member 1, and 12.

[0048]In drawing 13 and drawing 14, 17 is chromium or nickel with which the wire gauze of the outer passages of a light-gage small tube was plated or coated. 18 is chromium or nickel with which the wire gauze of the inside channel of a light-gage small tube was plated or coated. The wire gauze 3a which plated or coated chromium or nickel, and the wire gauze 3 which has not carried out plating or coating are laminated by turns.

[0049]When the diffused junction of the up-and-down wire gauze 3, 3a, or 4 and the 4a becomes is hard to be carried out as for this and a thermal combination of the wire gauze 3, 3a, or 4 and 4a becomes weak, the heat intruding of the wire gauzes 3 and 3a or the shaft orientations from 4 and 4a decreases. Therefore, heat exchanging quantity increases that much and a heat exchanger with sufficient heat exchanging efficiency can be provided.

[0050]

[Effect of the Invention]According to this invention, the heat intruding of the shaft orientations from the elevated-temperature side of a heat exchanger to the low temperature side can be reduced, the thermal resistance of a light-gage small tube and the joining section of a wire gauze can be reduced further, and the heat exchanger which improved 1% or more with temperature efficiency compared with the conventional heat exchanger can be provided. By having made efficiency of the heat exchanger high, it is effective in raising the efficiency of the cooling system incorporating this heat exchanger, and the small weight saving of a cooling system and power-saving can be further attained rather than before.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a sectional view of the heat exchanger which is the 1st example of this invention.

[Drawing 2]It is an A-A sectional view of the heat exchanger which is the 1st example of this invention.

[Drawing 3]It is a sectional view of the heat exchanger which is the 2nd example of this invention.

[Drawing 4]It is an A-A sectional view of the heat exchanger which is the 2nd example of this invention.

[Drawing 5]It is a sectional view of the heat exchanger which is the 3rd example of this invention.

[Drawing 6]It is an A-A sectional view of the heat exchanger which is the 3rd example of this invention.

[Drawing 7]It is a sectional view of the heat exchanger which is the 4th example of this invention.

[Drawing 8]It is an A-A sectional view of the heat exchanger which is the 4th example of this invention.

[Drawing 9]It is a sectional view of the heat exchanger which is the 5th example of this invention.

[Drawing 10]It is an A-A sectional view of the heat exchanger which is the 5th example of this invention.

[Drawing 11]It is a sectional view of the heat exchanger which is the 6th example of this invention.

[Drawing 12]It is an A-A sectional view of the heat exchanger which is the 6th example of this invention.

[Drawing 13]It is a sectional view of the heat exchanger which is the 7th example of this invention.

[Drawing 14]It is an A-A sectional view of the heat exchanger which is the 7th example of this invention.

[Drawing 15]It is the thermal conductivity of Lynn deoxidized copper and cupro nickel.

[Drawing 16]It is an explanatory view showing the conventional heat exchanger.

[Drawing 17]It is an explanatory view showing the conventional heat exchanger.

[Drawing 18]It is an explanatory view showing the conventional heat exchanger.

[Description of Notations]

1 ·· Cylindrical member

2 ·· Light-gage small tube

3, 4 ·· Wire gauze

5, 7 -- Stopper

6, 8 -- Diaphragm

9, 10 -- Lid

11 -- Entrance of outer passages

12 -- Entrance of an inside channel

13 -- Exit of outer passages

14 -- Exit of an inside channel

15, 16 -- The copper wax, the silver solder, nickel wax, or solder with which the light-gage small tube was coated

17, 18 -- Chromium or nickel with which the wire gauze was coated

19 -- The metal of the same construction material as the wire gauze with which the light-gage small tube was coated or copper, chromium, nickel, silver, or those alloys

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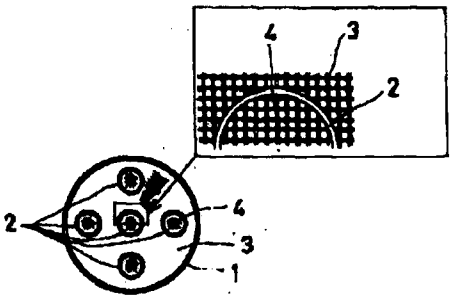
DRAWINGS

[Drawing 2]



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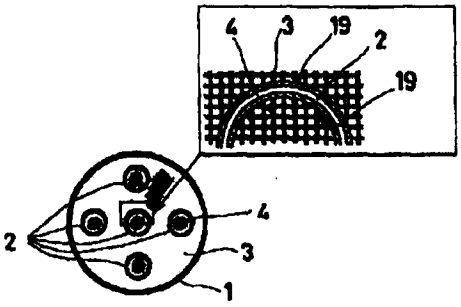

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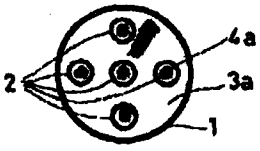

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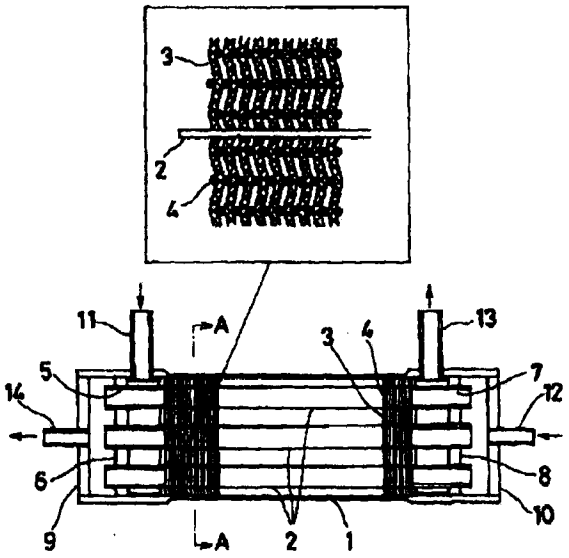

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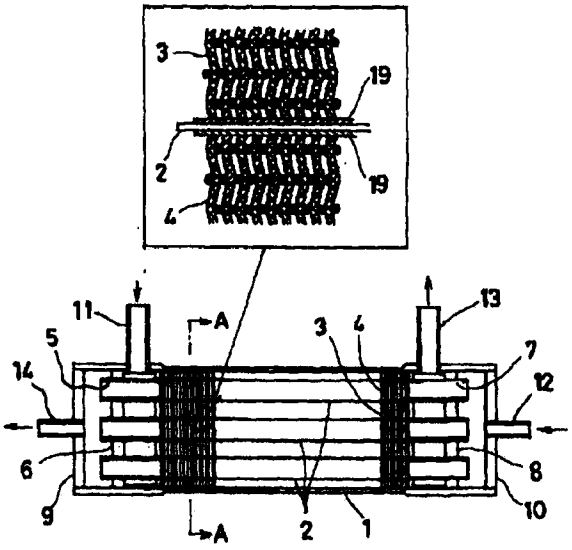

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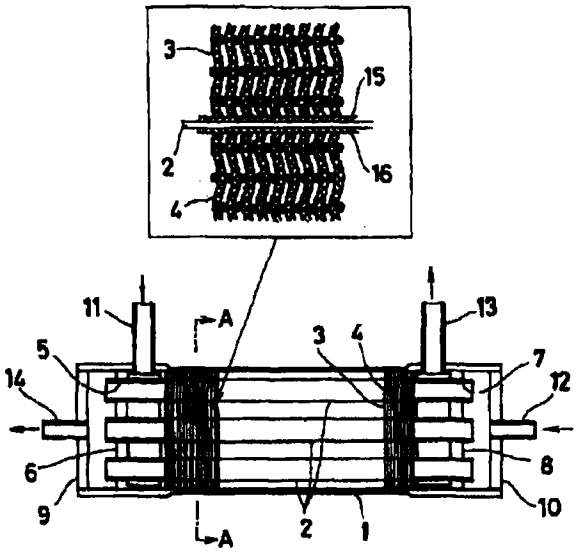

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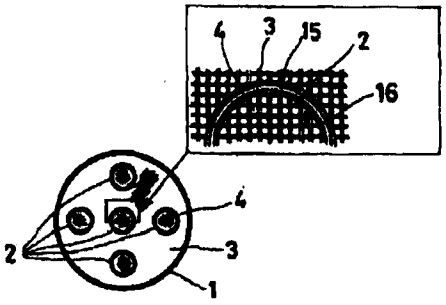

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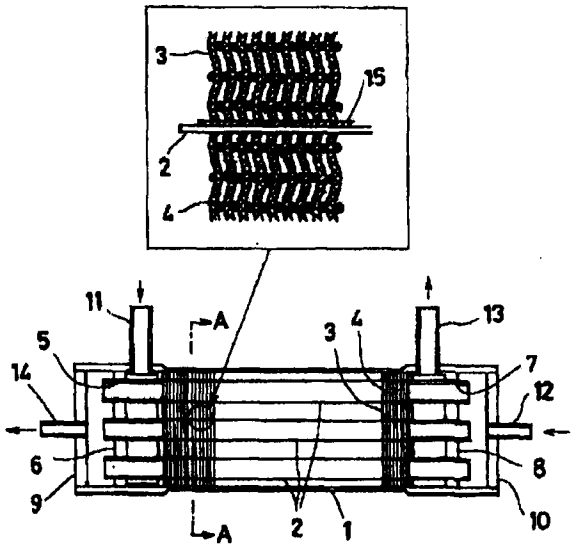

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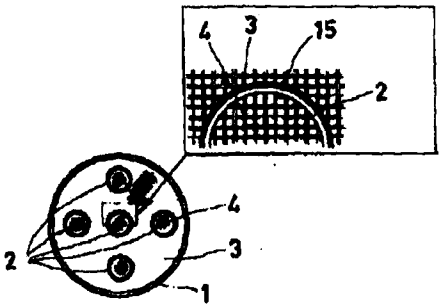

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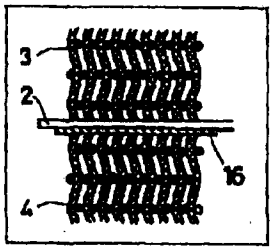

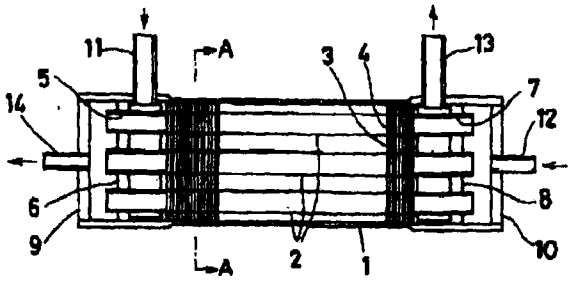

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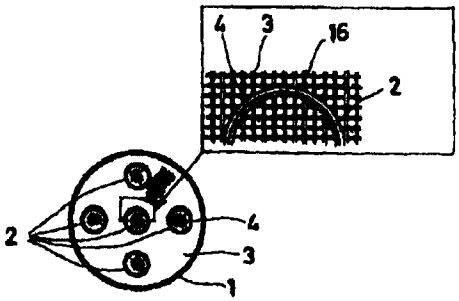

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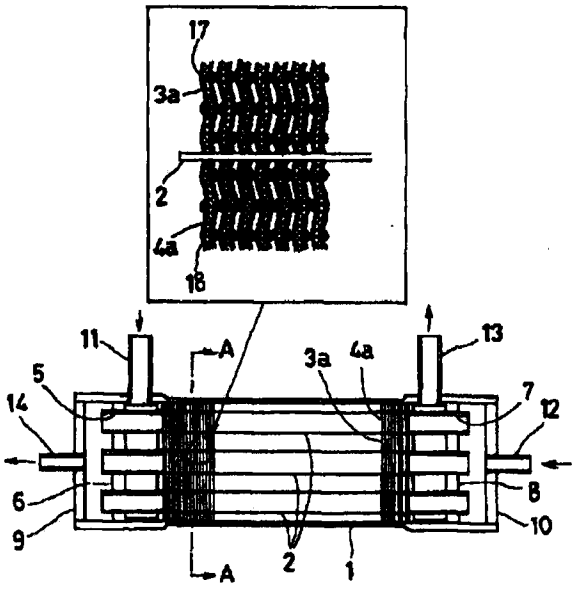

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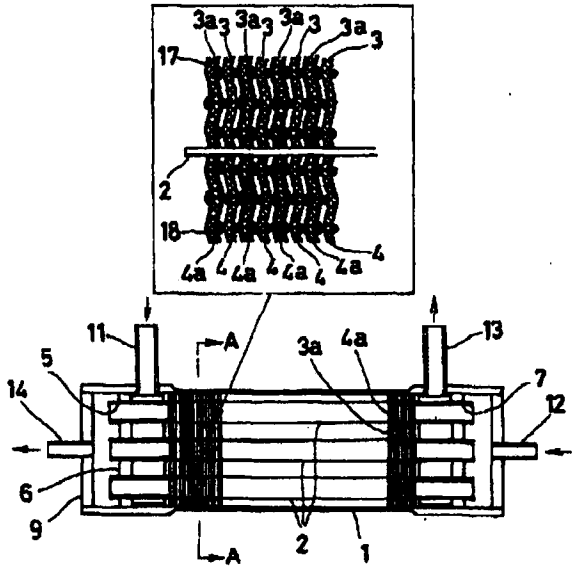

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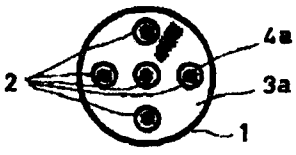

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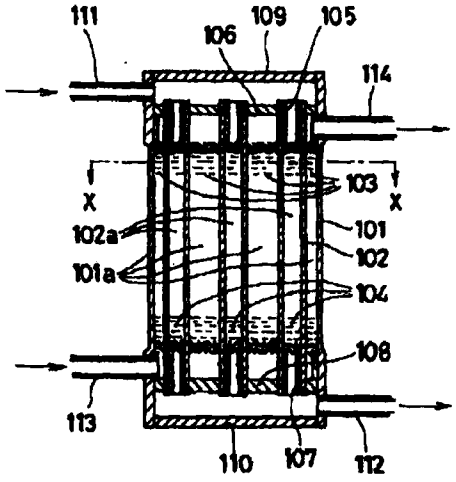

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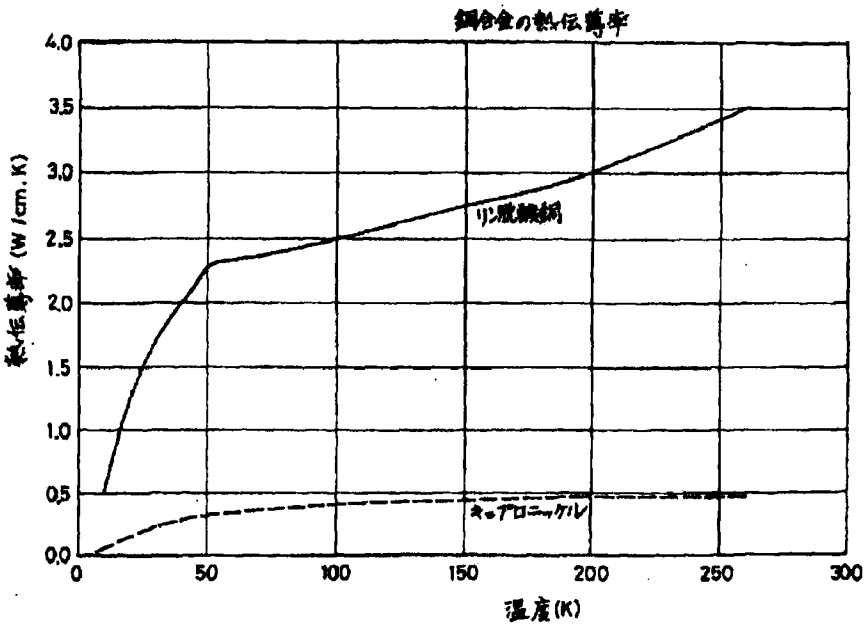

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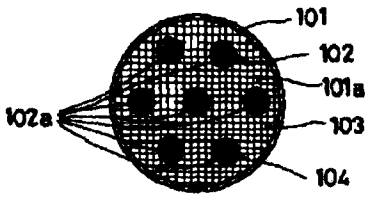

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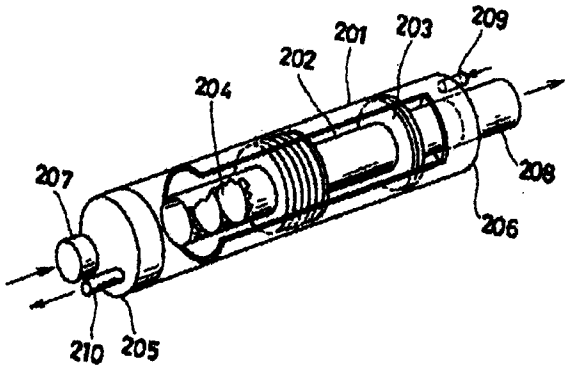

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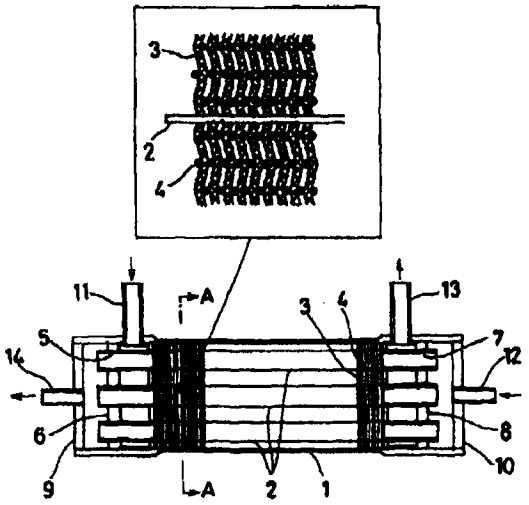
(71)出願人　000000011
アイシン精機株式会社
愛知県刈谷市朝日町２丁目１番地
(72)発明者　平野　明良
愛知県刈谷市朝日町２丁目１番地　アイシン精機株式会社内

Ｆターム(参考)　3L103 AA05 AA32 AA37 DD08 DD33 DD42 DD62 DD67

(54)【発明の名称】　熱交換器

(57)【要約】
【課題】熱交換器の薄肉細管２と金網３、４からの熱侵入を低減し、薄肉細管２と金網３、４との接触熱抵抗を小さくして熱交換器の効率を向上する。
【解決手段】熱交換器の薄肉細管２に熱伝導率の小さい銅合金（例えばキュプロニッケル）に変更し、金網３、４にはクロムまたはニッケルをコーティングする。また薄肉細管２の表面に金網と同じ金属、もしくはろう材をコーティングする。



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【特許請求の範囲】

【請求項1】　積層した金属金網間で壁を介して熱交換する熱交換器に於いて、筒状部材と、該筒状部材の中にあり前記筒状部材と平行に配設される1本または複数本の薄肉細管と、該薄肉細管と前記筒状部材の間に形成される外側流路と、前記薄肉細管の内側に形成される少なくとも1つ以上の内側流路と、前記外側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網と、前記内側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網とから成り、前記薄肉細管の材質を銅または銅合金にニッケルが5～40wt%含有する銅合金としたことを特徴とする熱交換器。

【請求項2】　前記薄肉細管の内面と外面、もしくはそのどちらか一方の表面に前記金網と同材質の金属、もしくは銅、クロム、ニッケル、銀、又はそれらの合金をコーティング又はメッキして、前記薄肉細管と前記金網を拡散接合したことを特徴とする請求項1記載の熱交換器。

【請求項3】　前記薄肉細管の内面と外面、もしくはそのどちらか一方の表面にろう材又は接着剤をコーティング又はメッキして、前記薄肉細管と前記金網との熱接触を強化したことを特徴とする請求項1記載の熱交換器。

【請求項4】　前記金網にコーティング又はメッキする金属が、クロム又はニッケルであることを特徴とする請求項1、2、3記載の熱交換器。

【請求項5】　コーティング又はメッキした前記金網が、コーティング又はメッキしていない金網の中に、少なくとも1枚以上のピッチで積層したことを特徴とする請求項4記載の熱交換器。

【請求項6】　積層した金属金網間で壁を介して熱交換する熱交換器に於いて、筒状部材と、該筒状部材の中にあり前記筒状部材と平行に配設される1本または複数本の銅またはリン脱酸銅から成る薄肉細管と、該薄肉細管と前記筒状部材の間に形成される外側流路と、前記薄肉細管の内側に形成される少なくとも1つ以上の内側流路と、前記外側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網と、前記内側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網とから成り、前記金網にコーティング又はメッキする金属が、クロム又はニッケルであることを特徴とする熱交換器。

【請求項7】　コーティング又はメッキした前記金網が、コーティング又はメッキしていない金網の中に、少なくとも1枚以上のピッチで積層したことを特徴とする請求項6記載の熱交換器。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、向流型熱交換器の改良に係るものである。

【0002】

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【従来の技術】従来この種の装置としては、特開昭60-243484号公報に開示されているもの、およびLos Alamos Scientific Laboratoryの「Low Flow Velocity, Fine-Screen Heat Exchengers and Vapor-Cooled Cryogenic Current Leads」がある。

【0003】図16、17に示すのは、特開昭60-243484号公報に開示されているもので、従来の熱交換器である。図16、17において101は筒状部材、102はこの筒状部材101の中にこれと平行する7本の薄肉細管、103はこの筒状部材101と薄肉細管102の間に形成される空間内に密に積層された金網、104は薄肉配管の内部に密に積層された金網である。それぞれの金網103および104の薄肉細管102の壁面に接触する部分が薄肉配管に拡散接合している。105および107は積層された金網104を保持するストッパ、106および108は薄肉細管102および積層された金網103を保持する仕切り板、109および110は筒状部材101の蓋、111は薄肉細管102の内側流路102aの入口、112は薄肉細管102の内側流路102aの出口、113は薄肉細管102の外側流路101aの入口、114はこの外側流路111aの出口である。このように細かい金網103、104を密に積層することにより熱伝導率の増大と実質的な伝熱面積の増大を行っている。

【0004】111から入ってきた高圧のガスは、低圧の戻りガスにより熱交換器の中で徐々に温度を下げながら112から出て行く。113から入ってきた低圧の戻りガスは、高圧のガスから熱をもらい徐々に温度を上げ114から出て行く。この時、高圧のガスと低圧のガスとで熱交換を行う。

【0005】高圧のガスと低圧のガスの低圧比熱が等しい場合、熱交換効率が100%ならば113の低圧入口のガス温度に112の高圧出口のガス温度が等しくなる。また111の高圧入口の温度に、114の低圧出口の温度が等しくなる。

【0006】しかし、熱交換器の効率は、100%ではなく非効率分が必ずあるため、熱交換器の高圧ガス出口温度は低圧入口ガス温度より高い温度で出て行く。また低圧出口温度は、高圧入口温度よりも低い温度で出て行く。

【0007】図18に示すものは、Los Alamos Scientific Laboratoryの「Low Flow Velocity, Fine-Screen Heat Exchengers and Vapor-CooledCryogenic Current Leads」に示された熱交換器である。

【0008】図18において、201は筒状配管、202はこの筒状部材201の中にこれと平行に位置する1

本の薄肉細管（材質は銅）、２０３はこの筒状部材２０１と薄肉細管２０２の間に形成される空間内に密に積層された金網（材質は銅または銅合金）、２０４は薄肉細管の内部に密に積層された金網（材質は銅または銅合金）である。それぞれの金網２０３および２０４の薄肉細管２０２の壁面に接触する部分が薄肉細管に拡散接合している。２０５および２０６は、筒状部材２０１の蓋、２０７は薄肉細管２０２の内側流路の入口、２０８は薄肉細管２０２の内側流路の出口、２０９は薄肉細管２０２の外側流路の入口、２１０はこの外側流路の出口である。このように細かい金網２０３、２０４を密に積層することにより熱伝導率の増大と実質的な伝熱面積の増大を行っている。またこの熱交換器は、温度レベルとして約約４．５Ｋ～３００Ｋまでの低温領域で使用できる。

【０００９】

【発明が解決しようとする課題】しかしながら従来の熱交換器は下記の要因により、熱交換効率が下がるという問題点があり、主なものとして次の２つがあげられる。

【００１０】要因１

熱交換器の高温側から低温側への軸方向の熱侵入により熱交換量が減少し、熱交換器の効率が低下する。

【００１１】熱交換器の高温側から低温側への軸方向の熱侵入の経路として、薄肉細管１０２および金網１０３、１０４が挙げられる。従来の熱交換器は、薄肉細管１０２の材質として、銅またはリン脱酸銅を使用している。低温時のリン脱酸銅の熱伝導率は、例えば２００Ｋで３．０Ｗ／ｃｍ・Ｋであり、薄肉細管１０２の断面積を０．４７ｃｍ2、長さを２０ｃｍ、温度差を２００Ｋとすると、熱侵入量は１４．１Ｗとなる。このため熱交換器の高温側から低温側への軸方向に１４．１Ｗの熱が侵入し、その分熱交換器の効率が低下する。

【００１２】また、金網１０３、１０４と薄肉細管１０２の拡散接合の熱処理のときに、上下の金網１０３、１０４同士も接合してしまい、熱的な接合も高くなるため、金網を通して高温側から低温側へ熱が侵入し、熱交換器の効率が低下する。

【００１３】要因２

外側流路の金網１０３と薄肉細管１０２および内側流路の金網１０４と薄肉細管の拡散接合部の接触熱抵抗が大きいことにより、軸直角方向または放射線方向の熱の伝導が阻害され熱交換量が低下し、熱交換器の効率が低下する。

【００１４】従来の熱交換器では、金網１０３、１０４と薄肉細管１０２を拡散接合している。しかし拡散接合は、熱処理のとき薄肉細管１０２と金網１０３、１０４が接触している部分しか接合されないという欠点がある。そのため薄肉細管１０２と金網１０３、１０４の接触部分の接触面積が小さく、この部分に熱抵抗を生じてしまうことになり、熱交換量が減少し、熱交換器の効率が低下する。

【００１５】

【課題を解決するための手段】請求項１の発明は、積層した金属金網間で壁を介して熱交換する熱交換器に於いて、筒状部材と、該筒状部材の中にあり前記筒状部材と平行に配設される１本または複数本の薄肉細管と、該薄肉細管と前記筒状部材の間に形成される外側流路と、前記薄肉細管の内側に形成される少なくとも１つ以上の内側流路と、前記外側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網と、前記内側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網とから成り、前記薄肉細管の材質を銅または銅合金にニッケルが５～４０ｗｔ％含有する銅合金としたことを特徴とする。

【００１６】請求項１の発明では、薄肉細管の材質を従来の銅、またはリン脱酸銅から、銅にニッケルが５～４０ｗｔ％含有する銅合金に変更することにより、熱交換器の高温側から低温側への軸方向の熱侵入が約１／６以下に減少し、熱交換器の効率が向上する。

【００１７】ニッケルの含有量が５ｗｔ％未満では、薄肉細管の熱伝導率が大きくなってしまい、高温側から低温側への軸方向の熱侵入が増加してしまう。またニッケルの含有量が４０ｗｔ％より大きい場合は、材料のコストの増加を招いてしまう。

【００１８】請求項２の発明は、前記薄肉細管の内面と外面、もしくはそのどちらか一方の表面に前記金網と同材質の金属、もしくは銅、クロム、ニッケル、銀、又はそれらの合金をコーティング又はメッキして、前記薄肉細管と前記金網を拡散接合したことを特徴とする。

【００１９】請求項２の発明では、金網と同材質の金属、もしくは銅および銅合金、クロム、ニッケル、銀をコーティングまたはメッキすることにより、拡散接合が強化され、接合部分の熱抵抗を低減させ、熱交換器の軸直角方向または放射線方向の熱伝導率を向上させ、熱交換効率のよい熱交換器を提供することができる。

【００２０】請求項３の発明は、前記薄肉細管の内面と外面、もしくはそのどちらか一方の表面にろう材又は接着剤をコーティング又はメッキして、前記薄肉細管と前記金網との熱接触を強化したことを特徴とする。

【００２１】請求項３の発明では、薄肉細管の内面と外面、もしくはそのどちらか一方の表面にろう材又は接着剤をコーティング又はメッキした後、熱処理を行うことにより、薄肉細管と金網の間にろう材または接着材が介在物として入り込むため、薄肉細管と金網の接触面積が増大する。

【００２２】請求項４の発明は、前記金網にコーティング又はメッキする金属が、クロム又はニッケルであることを特徴とする。

【００２３】請求項４の発明では、金網の表面にクロムまたはニッケルをコーティング又はメッキすることによ

り、熱交換器を熱処理したときに上下の金網が拡散接合し難くなり、熱交換器の高温側から低温側への軸方向の熱侵入が低減し、熱交換器の効率が向上する。

【００２４】請求項５の発明は、コーティング又はメッキした前記金網が、コーティング又はメッキしていない金網の中に、少なくとも１枚以上のピッチで積層したことを特徴とする。

【００２５】請求項５の発明では、金網の表面にクロムまたはニッケルをコーティング又はメッキしている金網を、コーティング又はメッキしていない金網の中に、１枚または数枚ピッチで積層することにより、熱交換器を熱処理したときに上下の金網が拡散接合し難くなり、熱交換器の高温側から低温側への軸方向の熱侵入が低減し、熱交換器の効率が向上する。

【００２６】請求項６の発明は、積層した金属金網間で壁を介して熱交換する熱交換器に於いて、筒状部材と、該筒状部材の中にあり前記筒状部材と平行に配設される１本または複数本の銅またはリン脱酸銅から成る薄肉細管と、該薄肉細管と前記筒状部材の間に形成される外側流路と、前記薄肉細管の内側に形成される少なくとも１つ以上の内側流路と、前記外側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網と、前記内側流路に密に積層され前記薄肉細管に熱接触して伝熱フィンを形成する金網とから成り、前記金網にコーティング又はメッキする金属が、クロム又はニッケルであることを特徴とする。

【００２７】請求項６の発明では、前記金網の表面にクロムまたはニッケルをコーティング又はメッキすることにより、熱交換器を熱処理したときに上下の金網が拡散接合し難くなり、熱交換器の高温側から低温側への軸方向の熱侵入が低減し、熱交換器の効率が向上する。

【００２８】請求項７の発明は、コーティング又はメッキした前記金網が、コーティング又はメッキしていない金網の中に、少なくとも１枚以上のピッチで積層したことを特徴とする。

【００２９】請求項７の発明では、金網の表面にクロムまたはニッケルをコーティング又はメッキしている金網を、コーティング又はメッキしていない金網の中に、１枚または数枚ピッチで積層することにより、熱交換器を熱処理したときに上下の金網が拡散接合し難くなり、熱交換器の高温側から低温側への軸方向の熱侵入が低減し、熱交換器の効率が向上する。

【００３０】

【発明の実施の形態】第１実施例

本発明の第１実施例である熱交換器の断面図を図１と図２に示す。図１と図２において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３はこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４は薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００３１】本実施例は、薄肉細管２をリン脱酸銅からニッケルが５～４０ｗｔ％含有する銅合金、例えばキュプロニッケルに変更したものである。図１５にリン脱酸銅および銅合金にニッケルが約１０ｗｔ％含有したキュプロニッケルの熱伝導率を示す。これによると、例えば１００Ｋにおいて、リン脱酸銅の熱伝導率２．５Ｗ／ｃｍ・Ｋに対してキュプロニッケルは、０．４Ｗ／ｃｍ・Ｋと約１／６になっている。このため熱交換器の効率が向上する。

【００３２】第２実施例

本発明の第２実施例である熱交換器の断面図を図３と図４に示す。図３と図４において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３はこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４は薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００３３】薄肉細の外側および内側もしくはそのどちらか一方の表面に、金網と同じ材質の金属１９（たとえば銅、クロム、ニッケル、銀、又はそれらの合金）をコーティングまたはメッキした場合、金網と薄肉細管２接触する部分の拡散接合が強化されるため、熱抵抗を低減することができる。

【００３４】このとき熱交換器の軸方向の熱侵入は増加するが、例えば銅の膜厚が２μｍとした場合、平均温度２００Ｋで薄肉細管の長さを２０ｃｍ、温度差を２００Ｋとすると、熱侵入量は約０．０４Ｗとなり、熱侵入量の増加は無視できるほど小さい。

【００３５】第３実施例

本発明の第３実施例である熱交換器の断面図を図５と図６に示す。図５と図６において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３はこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４は薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉

細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００３６】１５は薄肉細管外側にコーティングまたはメッキした銅ろう、銀ろう、ニッケルろう材またはハンダ、また１６は薄肉細管内側にコーティングまたはメッキした銅ろう、銀ろう、ニッケルろう材またはハンダである。

【００３７】これにより薄肉細管２と金網３、４の接合部分の熱抵抗を低減させ、熱交換器の軸直角方向または放射線方向の熱伝導率を向上させ、熱交換効率の良い熱交換器を提供することができる。さらに融点の低い銅ろう材を使用することにより、熱処理の温度を下げることができ、その結果金網３、４同士の拡散接合強度を弱くすることができる。これにより熱交換器の軸方向の熱侵入を減らす効果も期待できる。

【００３８】第４実施例

本発明の第４実施例である熱交換器の断面図を図７と図８に示す。図７と図８において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３はこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４は薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００３９】第４実施例は、１５は薄肉細管外側にコーティングまたはメッキした銅ろう、銀ろう、ニッケルろう材またはハンダである。

【００４０】これにより薄肉細管２と金網３の接合部分の熱抵抗を低減させ、熱交換器の軸直角方向または放射線方向の熱伝導率を向上させ、熱交換効率の良い熱交換器を提供することができる。さらに融点の低い銅ろう材を使用することにより、熱処理の温度を下げることができ、その結果金網３、４同士の拡散接合強度を弱くすることができる。これにより熱交換器の軸方向の熱侵入を減らす効果も期待できる。

【００４１】第５実施例

本発明の第５実施例である熱交換器の断面図を図９と図１０に示す。図９と図１０において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３はこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４は薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００４２】第５実施例は、１６は薄肉細管内側にコーティングまたはメッキした銅ろう、銀ろう、ニッケルろう材またはハンダである。

【００４３】これにより薄肉細管２と金網４の接合部分の熱抵抗を低減させ、熱交換器の軸直角方向または放射線方向の熱伝導率を向上させ、熱交換効率の良い熱交換器を提供することができる。さらに融点の低い銅ろう材を使用することにより、熱処理の温度を下げることができ、その結果金網同士の拡散接合強度を弱くすることができる。これにより熱交換器の軸方向の熱侵入を減らす効果も期待できる。

【００４４】第６実施例

本発明の第６実施例である熱交換器の断面図を図１１と図１２に示す。図１１と図１２において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３ａはこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４ａは薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００４５】図１１と図１２において１７は薄肉細管の外側流路の金網３ａにメッキまたはコーティングされたクロムまたはニッケルである。１８は薄肉細管の内側流路の金網４ａにメッキまたはコーティングされたクロムまたはニッケルである。

【００４６】これにより、上下の金網３ａ、４ａ同士が拡散接合されにくくなり、金網３ａ、４ａ同士の熱的な結合が弱くなることにより、金網３ａ、４ａからの軸方向の熱侵入が減少する。そのためその分熱交換量が増加し、熱交換効率のよい熱交換器を提供することができる。

【００４７】第７実施例

本発明の第７実施例である熱交換器の断面図を図１３と図１４に示す。図１３と図１４において１は筒状部材、２はこの筒状部材１の中にこれと平行に位置する５本の薄肉細管（ニッケルが５～４０ｗｔ％含有する銅合金）、３、３ａはこの筒状部材１と薄肉細管２の間に形成させる空間内に密に積層された金網、４、４ａは薄肉細管の内部に密に積層された金網である。５および７は積層された金網４を保持するストッパ、６および８は薄肉細管２および積層された金網３を保持する仕切り板、９および１０は筒状部材１の蓋、１２は薄肉細管２の内側流路の入口、１４は薄肉細管２の内側流路の出口、１

１は薄肉細管２の外側流路の入口、１３はこの外側流路の出口である。

【００４８】図１３と図１４において１７は薄肉細管の外側流路の金網にメッキまたはコーティングされたクロムまたはニッケルである。１８は薄肉細管の内側流路の金網にメッキまたはコーティングされたクロムまたはニッケルである。クロムまたはニッケルをメッキまたはコーティングした金網３ａと、メッキまたはコーティングをしていない金網３とを交互に積層したものである。

【００４９】これにより、上下の金網３、３ａまたは４、４ａ同士が拡散接合されにくくなり、金網３、３ａまたは４、４ａ同士の熱的な結合が弱くなることにより、金網３、３ａまたは４、４ａからの軸方向の熱侵入が減少する。そのためその分熱交換量が増加し、熱交換効率のよい熱交換器を提供することができる。

【００５０】

【発明の効果】本発明によれば、熱交換器の高温側から低温側への軸方向の熱侵入を低減し、さらに薄肉細管と金網の接合部分の熱抵抗を低減させ、従来の熱交換器に比べて温度効率で１％以上向上した熱交換器を提供することができる。また熱交換器の効率を高くしたことにより、この熱交換器を組み込んだ冷却装置の効率を向上させる効果があり、従来よりもさらに冷却装置の小型軽量化、省電力化が図れる。

【図面の簡単な説明】

【図１】本発明の第１実施例である熱交換器の断面図である。

【図２】本発明の第１実施例である熱交換器のＡ－Ａ断面図である。

【図３】本発明の第２実施例である熱交換器の断面図である。

【図４】本発明の第２実施例である熱交換器のＡ－Ａ断面図である。

【図５】本発明の第３実施例である熱交換器の断面図である。

【図６】本発明の第３実施例である熱交換器のＡ－Ａ断面図である。

【図７】本発明の第４実施例である熱交換器の断面図で＊ある。

【図８】本発明の第４実施例である熱交換器のＡ－Ａ断面図である。

【図９】本発明の第５実施例である熱交換器の断面図である。

【図１０】本発明の第５実施例である熱交換器のＡ－Ａ断面図である。

【図１１】本発明の第６実施例である熱交換器の断面図である。

【図１２】本発明の第６実施例である熱交換器のＡ－Ａ断面図である。

【図１３】本発明の第７実施例である熱交換器の断面図である。

【図１４】本発明の第７実施例である熱交換器のＡ－Ａ断面図である。

【図１５】リン脱酸銅およびキュプロニッケルの熱伝導率である。

【図１６】従来の熱交換器を示す説明図である。

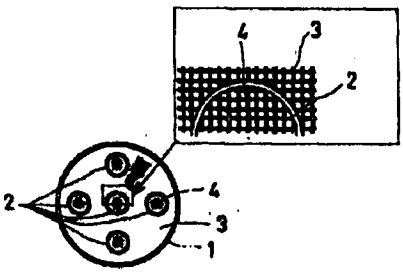
【図１７】従来の熱交換器を示す説明図である。

【図１８】従来の熱交換器を示す説明図である。

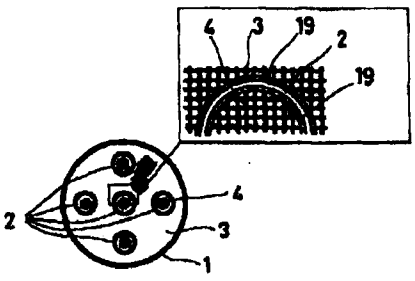
【符号の説明】

１…筒状部材
２…薄肉細管
３、４…金網
５、７…ストッパ
６、８…仕切り板
９、１０…蓋
１１…外側流路の入口
１２…内側流路の入口
１３…外側流路の出口
１４…内側流路の出口
１５、１６…薄肉細管にコーティングした銅ろう、銀ろう、ニッケルろうまたはハンダ
１７、１８…金網にコーティングしたクロムまたはニッケル
１９…薄肉細管にコーティングした金網と同じ材質の金属、もしくは銅、クロム、ニッケル、銀、又はそれらの合金

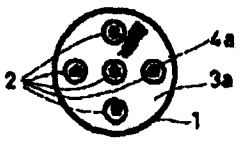
【図２】



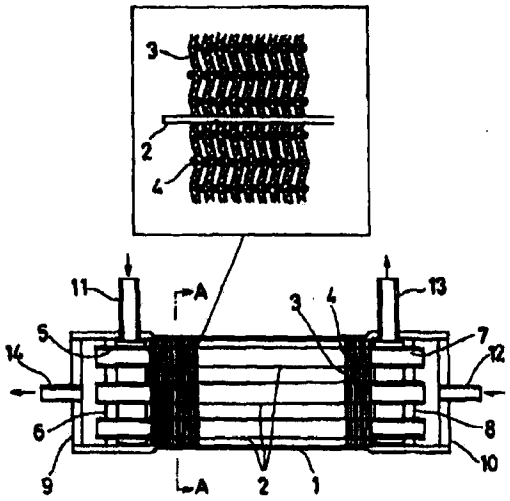
【図４】



【図１２】



【図1】



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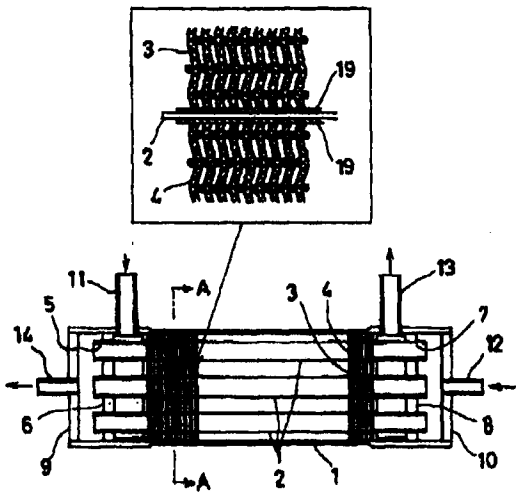

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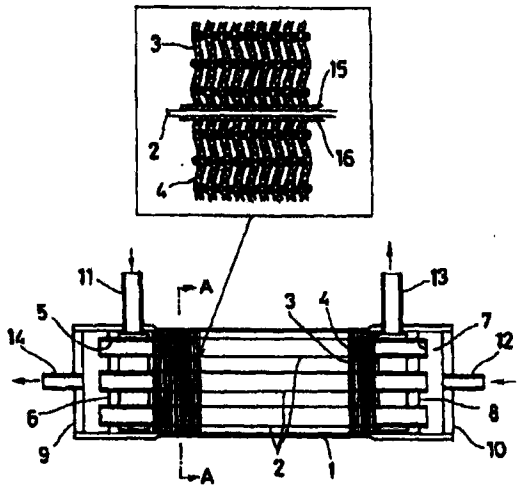

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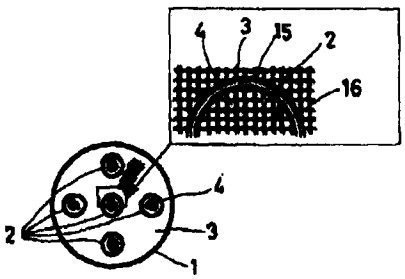

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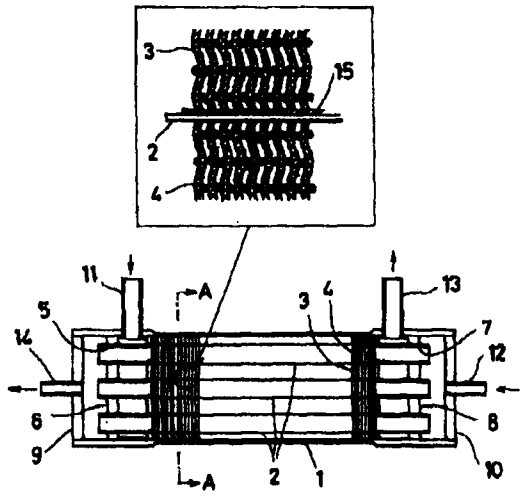
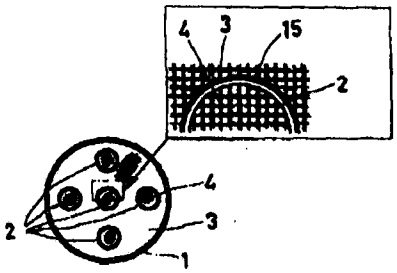
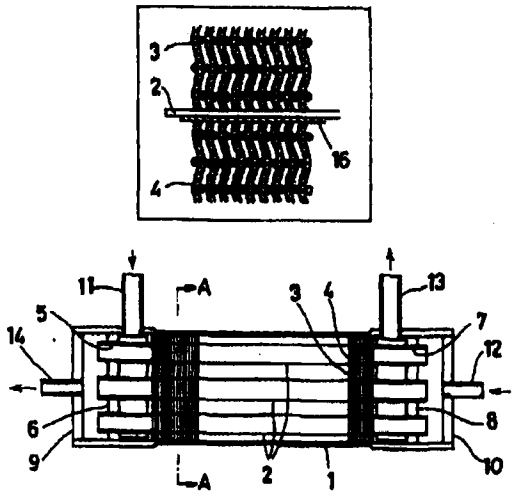


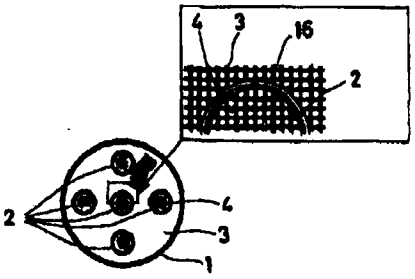
【図8】



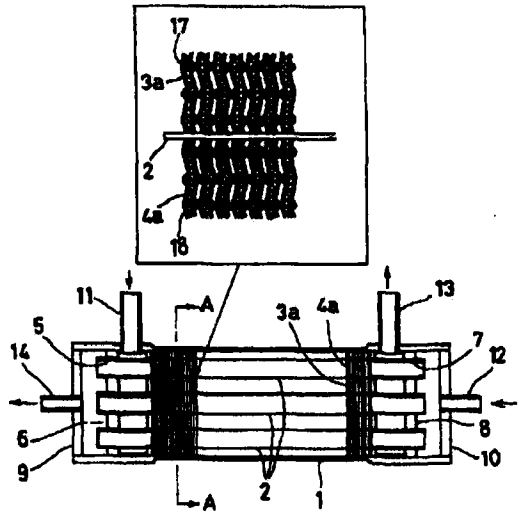
【図9】



【図10】



【図11】



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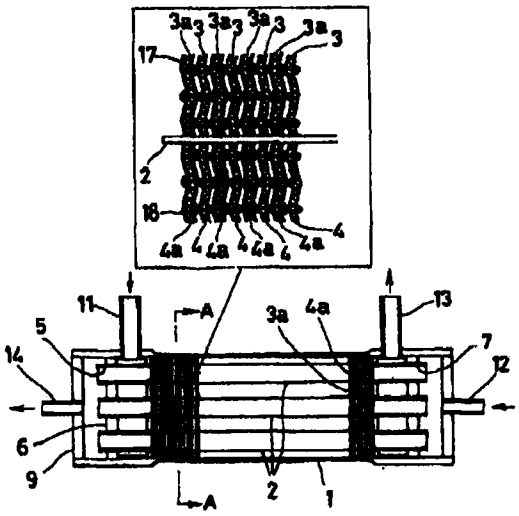
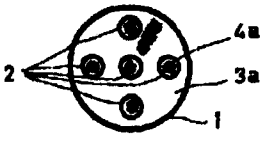


【図14】



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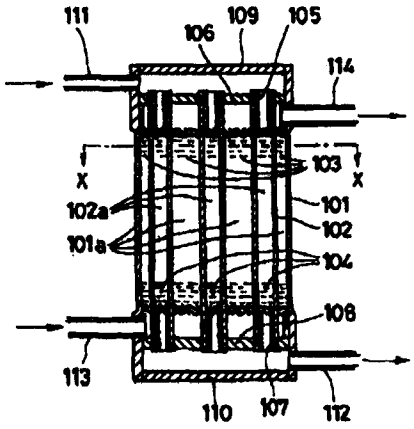

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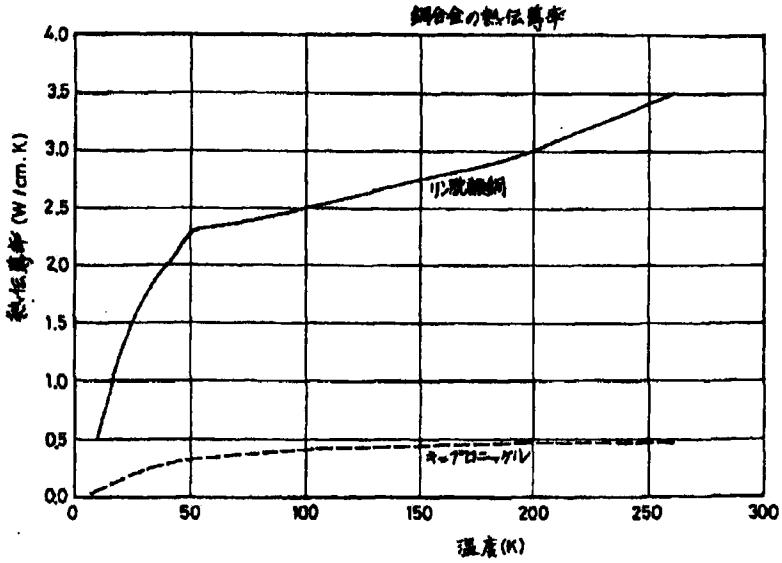
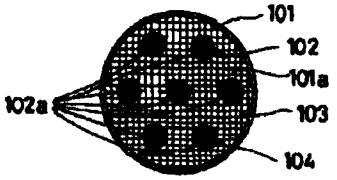
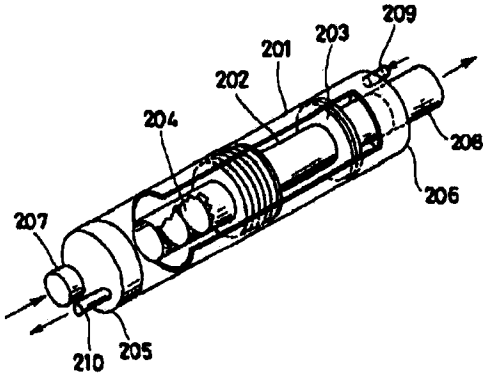

銅合金の熱伝導率
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
温度(K)

【図17】


101
102
101a
102a
103
104

【図18】


209
203
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205